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**Okun et al.**

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(54) **TWO-WAY WIRELESS COMMUNICATION  
ENABLED INTRUSION DETECTOR  
ASSEMBLIES**

USPC ..... 340/547, 541, 542; 235/492; 716/137  
See application file for complete search history.

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(2013.01); **H01Q 13/16** (2013.01)

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CPC ..... G08B 13/08; H01Q 1/38; H01Q 1/40;  
H01Q 13/16; H01Q 9/0407

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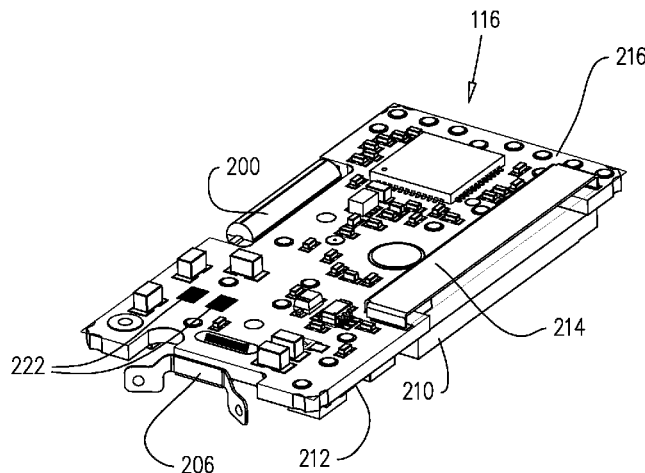
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(57)

**ABSTRACT**

A fixed magnetic contact wireless transceiver including a two-way transceiver element adapted to be operable for two-way wireless communication between a fixed magnetic contact wireless transceiver component and an intrusion alarm system, an antenna facilitating the two-way wireless communication between the fixed magnetic contact wireless transceiver component and the intrusion alarm system, and an antenna ground reference plane, opposite the antenna, wherein the antenna includes a substrate, a top surface of the substrate being coated with a gold plated copper substrate coating, the coating having a gap formed therein, and half via holes formed in a perimeter of the antenna, the half via holes being coated with gold plated copper half via hole coatings which form a continuum with the gold plated copper substrate coating.

**28 Claims, 6 Drawing Sheets**



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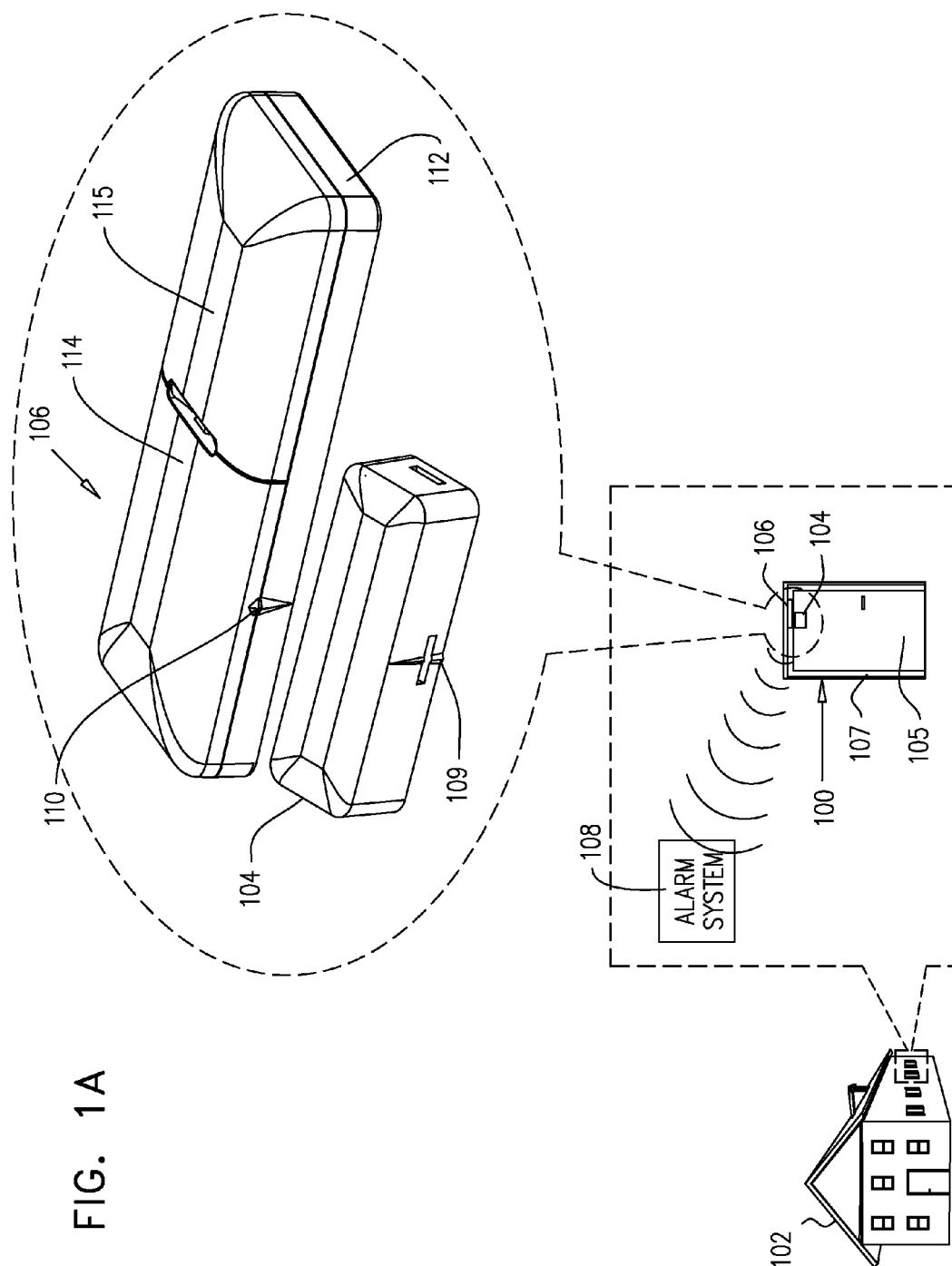


FIG. 1B

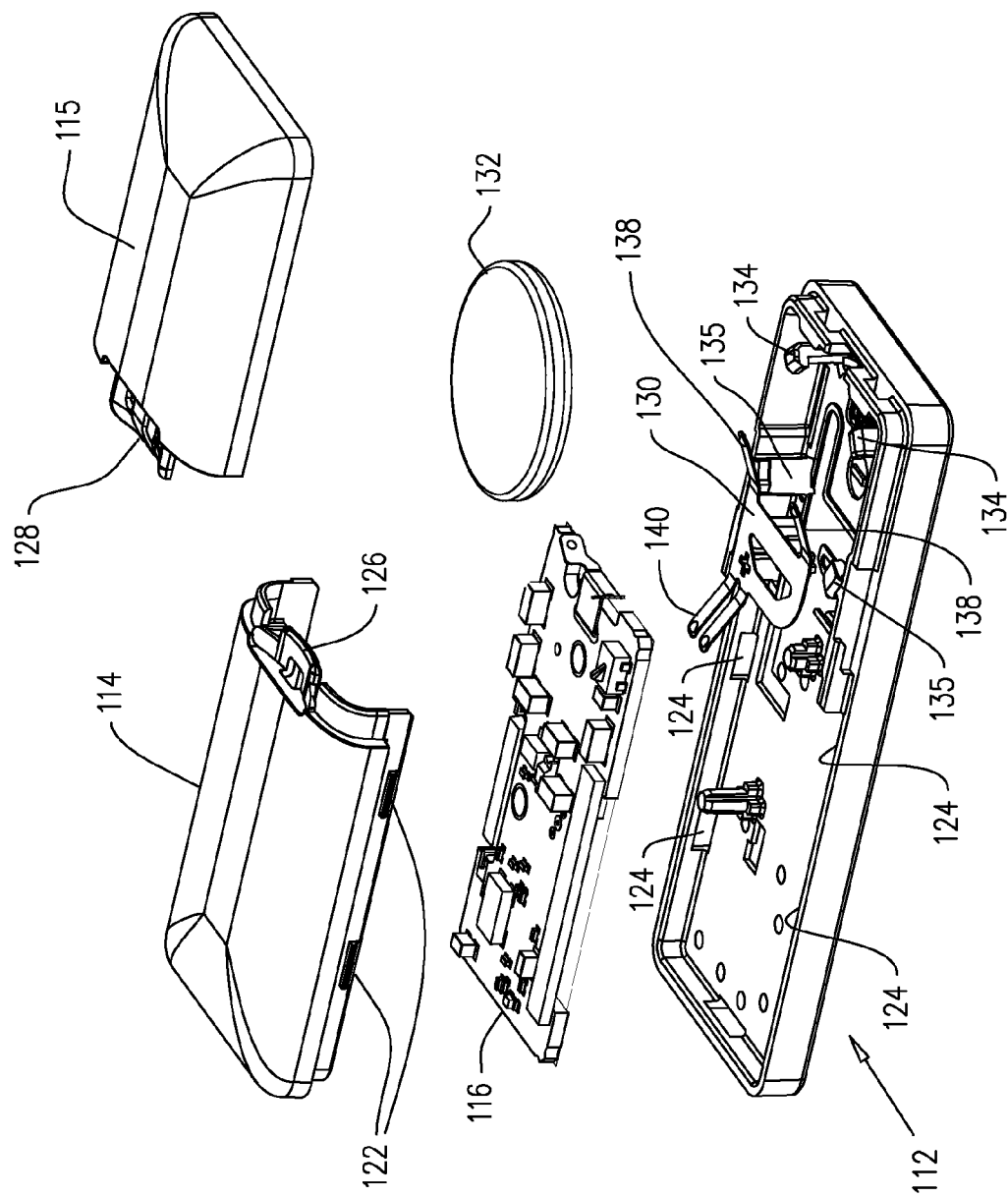


FIG. 2A

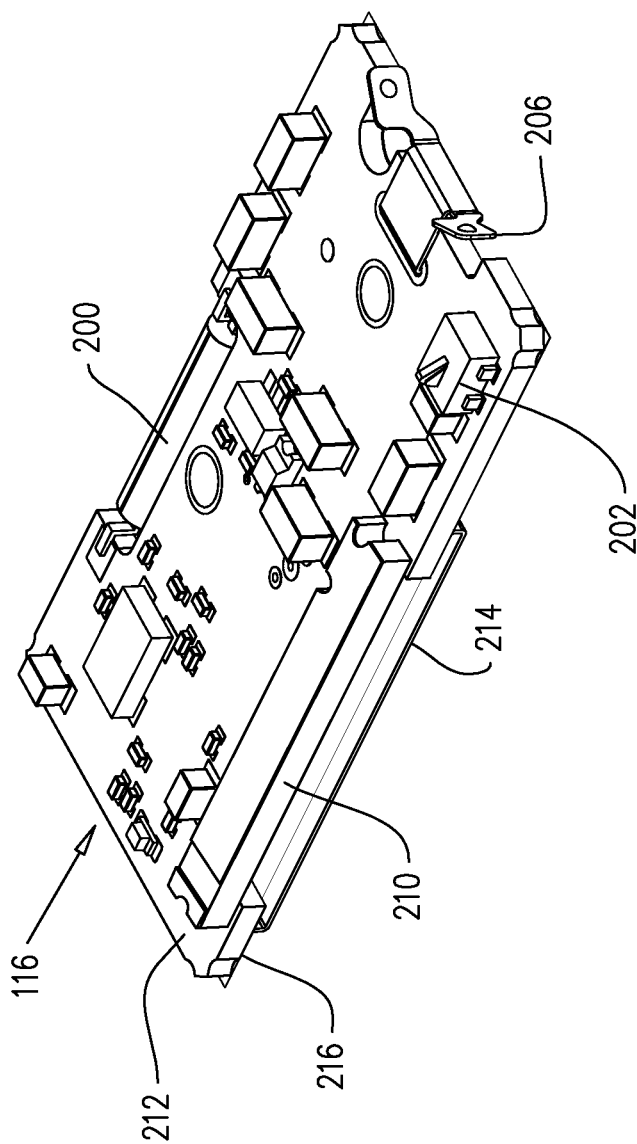


FIG. 2B

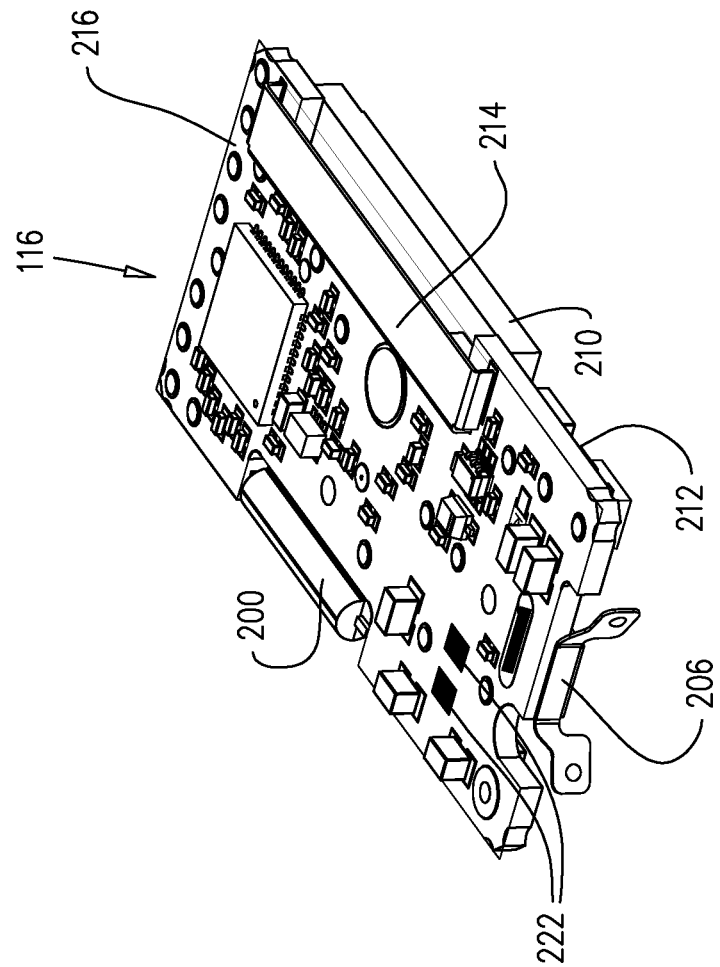


FIG. 2C

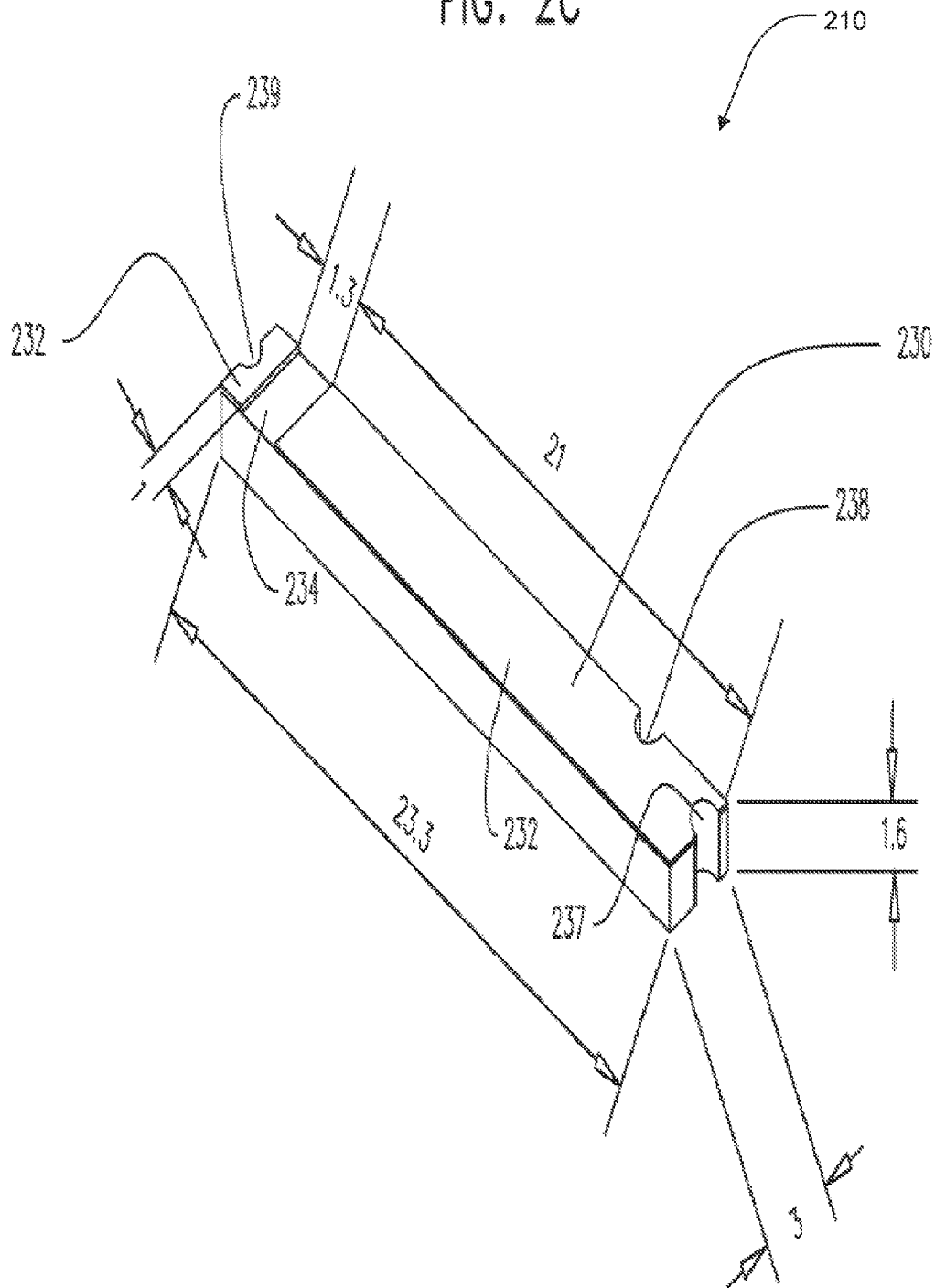
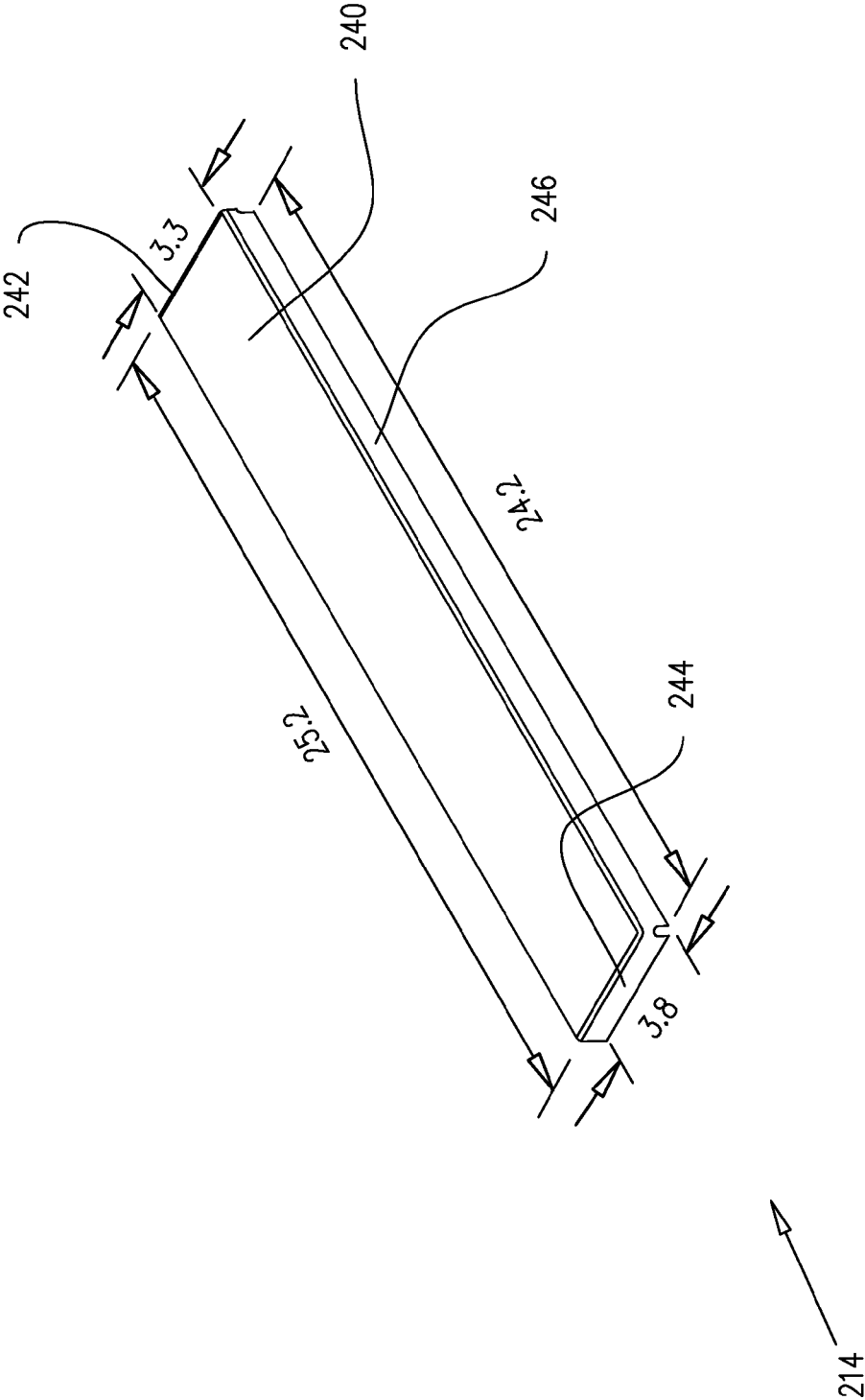


FIG. 2D





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## TWO-WAY WIRELESS COMMUNICATION ENABLED INTRUSION DETECTOR ASSEMBLIES

### REFERENCE TO RELATED APPLICATION

This application is a Continuation-in-Part of U.S. application Ser. No. 14/153,135 filed on Jan. 13, 2014, the entire contents of which are incorporated by reference herein.

### FIELD OF THE INVENTION

The present invention relates to two-way wireless communication enabled intrusion detectors and intrusion detector assemblies.

### BACKGROUND OF THE INVENTION

Intrusion detectors typically employed in door or window intrusion detector assemblies are typically prone to be visible to potential intruders. It is therefore advantageous to provide intrusion detectors which are small and easy to conceal.

Additionally, it is advantageous to provide intrusion detectors which communicate with a central alarm system via wireless communication, thereby eliminating the need for installation of communication wiring.

It is further advantageous to provide intrusion detectors which communicate wirelessly via a two-way communication system, thereby facilitating more reliable communication that is less prone to interference or blocking.

The present invention therefore seeks to provide an intrusion detector assembly having a narrow physical profile, while providing intrusion detection capabilities and two-way wireless communication functionality for communicating with an alarm system.

### SUMMARY OF THE INVENTION

The present invention seeks to provide improved two-way wireless communication enabled intrusion detectors and intrusion detector assemblies.

There is thus provided in accordance with a preferred embodiment of the present invention a fixed magnetic contact wireless transceiver including a two-way transceiver element adapted to be operable for two-way wireless communication between a fixed magnetic contact wireless transceiver component and an intrusion alarm system, an antenna facilitating the two-way wireless communication between the fixed magnetic contact wireless transceiver component and the intrusion alarm system, and an antenna ground reference plane, opposite the antenna, wherein the antenna includes a substrate, a top surface of the substrate being coated with a gold plated copper substrate coating, the coating having a gap formed therein, and half via holes formed in a perimeter of the antenna, the half via holes being coated with gold plated copper half via hole coatings which form a continuum with the gold plated copper substrate coating of the substrate.

Additionally, the antenna ground reference plane includes a flat elongate portion, first and second downward folded end portions extending downwardly from corresponding first and second ends of the flat elongate portion, and an elongate folded side portion extending from a side edge of the flat elongate portion.

Preferably, the antenna has a volume of less than 112 cubic millimeters. More preferably, the antenna has a volume of 111.84 cubic millimeters. Preferably, the antenna has a length of less than 24 millimeters, a width of less than 4 millimeters,

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and a thickness less than 2 millimeters. More preferably, the antenna has a length of 23.3 millimeters, a width of 3 millimeters, and a thickness of 1.6 millimeters.

Preferably, the flat elongate portion has a volume of less than 16 cubic millimeters. More preferably, the flat elongate portion has a volume of 15.972 cubic millimeters. Preferably, the flat elongate portion has a length of less than 25 millimeters, a width of less than 4 millimeters and a thickness less than 0.5 millimeters, each of the first and second downward folded end portions has a width of less than 4 millimeters and a thickness of less than 0.5 millimeters, and extends downwardly less than 1.5 millimeters from the corresponding first and second ends of the flat elongate portion, and the elongate folded side portion extends outwardly less than 1 millimeter and downwardly less than 1.5 millimeters from the side edge of the flat elongate portion. More preferably, the flat elongate portion has a length of 24.2 millimeters, a width of 3.3 millimeters and a thickness of 0.2 millimeters, each of the first and second downward folded end portions has a width of 3.3 millimeters and a thickness of 0.2 millimeters, and extends downwardly 1.1 millimeters from the corresponding first and second ends of the flat elongate portion, and the elongate folded side portion extends outwardly 0.5 millimeters and downwardly 1.1 millimeters from the side edge of the flat elongate portion.

Preferably, the fixed magnetic contact wireless transceiver also includes a REED switch operable for sensing changes in a magnetic field induced by the magnet component, the changes being potentially indicative of an intrusion and for communicating indications of the changes to the alarm system via the two-way transceiver component.

Preferably, the magnet component includes a contact component installation marker for alignment thereof with a corresponding transceiver component installation marker included on the fixed magnetic contact wireless transceiver component, upon installation of the magnet component and the fixed magnetic contact wireless transceiver component.

Preferably, the fixed magnetic contact wireless transceiver component also includes a bottom housing element and two interconnecting top housing elements. Preferably, at least one of the interconnecting top housing elements includes at least one snap-in element integrally formed therein, configured for snap-in engagement with at least one recess formed in the bottom housing element, thereby fastening the at least one of the interconnecting top housing elements to the bottom housing element and retaining the two-way transceiver element within the top and bottom housing elements.

Preferably, a first one of the interconnecting top housing elements is configured for slidable fastening thereof onto the bottom housing element and for interconnecting with a second one of the interconnecting top housing elements via interconnecting latch elements integrally formed on each of the interconnecting top housing elements.

Preferably, the bottom housing element includes a battery housing element for housing a battery, and at least one snap-in element operable for retaining the battery within the battery housing. Preferably, the battery housing element includes at least one battery engaging element and at least one battery circuit engaging element, and the two-way transceiver element includes at least one transceiver circuit engaging element, the battery engaging element being operable for galvanically connecting a negative contact of the battery with the at least one battery circuit engaging element, the at least one battery circuit engaging element being operable for galvanic engagement with the at least one transceiver circuit engaging

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element of the two-way transceiver element upon enclosing the two-way transceiver element within the housing elements.

Preferably, the fixed magnetic contact wireless transceiver component also includes a tamper switch, wherein an attempt to tamper with the fixed magnetic contact wireless transceiver component results in toggling of the tamper switch.

Preferably, the two-way transceiver element includes a battery engaging element operable for engaging a positive contact of the battery.

Preferably, the antenna is configured for high frequency communication with the alarm system, the high frequency being between 2405 and 2480 MHz.

Preferably, the antenna ground reference plane opposite the antenna is operative to improve the gain of the antenna and to diminish interfering effects of materials disposed in a vicinity of the fixed magnetic contact wireless transceiver component. Preferably, the materials include metals, and the interfering effects include at least one of mistuning of the antenna, degradation of performance of the antenna and degradation of a range of the antenna.

Preferably, the substrate of the antenna is formed of PCB. Preferably, the antenna ground reference plane is formed of stainless steel.

Preferably, the gap is located less than 2 millimeters from a first end of the antenna, and has a width which is less than 2 millimeters. More preferably, the gap is located 1 millimeter from a first end of the antenna, and has a width of 1.3 millimeters.

Preferably, the half via holes include a first half via hole formed in a second end of the antenna, opposite the first end of the antenna, the first half via hole being grounded, a second half via hole formed in the first end of the antenna, the second half via hole being operable as an input/output port of the antenna, and a third half via hole formed in a side of the antenna, the third half via hole being connected to ground. Preferably, a stray capacitance provided by the gap facilitates tuning of a frequency of the antenna.

### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description taken in conjunction with the drawings in which:

FIG. 1A is a simplified pictorial illustration of a wireless door/window magnetic contact transceiver for use in a door intrusion detection assembly, constructed and operative in accordance with a preferred embodiment of the present invention.

FIG. 1B is a simplified exploded view illustration of the wireless door/window magnetic contact transceiver of FIG. 1A;

FIGS. 2A & 2B are respective top and bottom view illustrations of a two-way transceiver element of the wireless door/window magnetic contact transceiver of FIGS. 1A & 1B, constructed and operative in accordance with the preferred embodiment of the present invention;

FIG. 2C is a simplified pictorial illustration of an antenna which is part of the two-way transceiver element of FIGS. 2A & 2B; and

FIG. 2D is a simplified pictorial illustration of an antenna ground reference plane which is part of the two-way transceiver element of FIGS. 2A & 2B.

### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is now made to FIG. 1A, which is a simplified pictorial illustration of a wireless door/window magnetic

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contact transceiver for use in a door/window intrusion detection assembly, constructed and operative in accordance with a preferred embodiment of the present invention, and to FIG. 1B, which is a simplified exploded view illustration of the wireless door/window magnetic contact transceiver of FIG. 1A.

As shown in FIG. 1A, a door intrusion detection assembly **100** of a residence **102** preferably includes a magnet component **104** installed on a door **105** and a fixed magnetic contact wireless transceiver component **106** installed on a corresponding door frame **107**. Fixed magnetic contact wireless transceiver component **106** is preferably operable for wirelessly communicating with an alarm system **108** protecting home **102**.

It is appreciated that magnet component **104** and fixed magnetic contact wireless transceiver component **106** are of a narrow physical profile, thereby facilitating concealment of magnet component **104** and fixed magnetic contact wireless transceiver component **106** from potential intruders.

A contact component installation marker **109** is preferably provided on magnet component **104** for alignment with a corresponding transceiver component installation marker **110** provided on wireless transceiver component **106** upon installation of magnet component **104** and wireless transceiver component **106** in door assembly **100**.

Fixed magnetic contact wireless transceiver component **106** preferably includes bottom housing element **112** and two interconnecting top housing elements **114** and **115**.

Turning now to FIG. 1B, it is shown that fixed magnetic contact wireless transceiver component **106** also includes a two-way transceiver element **116**. It is appreciated that two-way transceiver element **116** preferably operates in compliance with the ZigBee communication standard.

Snap-in elements **122** are preferably integrally formed in interconnecting top housing element **114** for snap-in engagement with recesses **124** formed in bottom housing element **112**, thereby fastening interconnecting top housing element **114** to bottom housing element **112** and retaining two-way transceiver element **116** within housing elements **112** and **114**. Interconnecting top housing element **115** is preferably configured for slidable fastening thereof onto bottom housing element **112** and for interconnecting with interconnecting top housing element **114** via interconnecting latch elements **126** and **128** formed on interconnecting top housing elements **114** and **115**, respectively.

Bottom housing element **112** preferably includes a battery housing element **130** for housing a battery **132**, which is preferably retained within battery housing **130** by a pair of snap-in elements **134** and a pair of retaining elements **135**.

Battery engaging elements **138** are preferably formed in battery housing element **130** for galvanically connecting a negative contact of battery **132** with battery circuit engaging elements **140**. Circuit engaging elements **140** are preferably configured for galvanic engagement with transceiver circuit engaging elements of two-way transceiver element **116** upon enclosing two-way transceiver element **116** within housing elements **112**, **114** and **115**.

Reference is now made to FIGS. 2A & 2B, which are respective top and bottom view illustrations of two-way transceiver element **116** of the wireless door/window magnetic contact transceiver of FIGS. 1A & 1B, constructed and operative in accordance with the preferred embodiment of the present invention.

As shown in FIGS. 2A & 2B, a REED switch **200** is provided for sensing changes in a magnetic field induced by magnet component **104** of door intrusion detection assembly **100** (FIG. 1A) installed in close proximity thereto. It is appreciated

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ciated that opening of door **105** upon which magnet component **104** is installed relative to door frame **107** upon which wireless transceiver component **106** is installed, is operative to create changes in the magnetic field sensed by REED switch **200**, and to thereby indicate opening of door **105**.

A tamper switch **202** is preferably provided on two-way transceiver element **116** for detecting disengaging of interconnecting top housing element **115** of fixed magnetic contact wireless transceiver component **106** from bottom housing element **112** and thereby indicating possible tampering with wireless transceiver component **106**.

A battery engaging element **206** is provided for engaging a positive contact of battery **132** housed in housing element **130** of top housing element **112** (FIG. 1B).

An antenna **210** is provided on a top surface **212** of two-way transceiver element **116** for two-way communication between wireless transceiver component **106** and alarm system **108**, and an antenna ground reference plane **214** is preferably provided on a bottom surface **216** of two-way transceiver element **116**, generally opposite antenna **210**. Antenna **210** is preferably a high frequency antenna operative for communicating, for example, between 2405 and 2480 MHz. It is appreciated that the configuration of antenna ground reference plane **214** opposite antenna **210** is operative to improve the gain of antenna **210** and to diminish interfering effects of various materials, such as metals, disposed in the vicinity of wireless transceiver component **106**. Such interfering effects may, for example, cause mistuning of antenna **210** or degradation of performance and range of antenna **210**.

As further shown in FIG. 2B, transceiver circuit engaging elements **222** are preferably provided for engaging battery circuit engaging elements **140** of bottom housing element **112** when two-way transceiver element **116** is in engagement with bottom housing element **112**.

Reference is now made to FIG. 2C, which is a simplified pictorial illustration of antenna **210** which is part of two-way transceiver element **116** of FIGS. 2A & 2B. As shown in FIG. 2C, antenna **210** has a length of 23.3 or 24 millimeters and a width of 3 millimeters. Antenna **210** preferably includes a substrate **230** preferably formed of PCB produced with, for example, IT-158BS multifunctional filled epoxy, commercially available from ITEQ Corporation of Taoyuan, Taiwan.

A top surface of substrate **230** is preferably coated with a gold plated copper coating **232**. A gap **234** is preferably formed in coating **232**, gap **234** being located approximately 1 millimeter from one end of antenna **210** and having a width of approximately 1.3 millimeters. It is appreciated that gold plated copper coating **232** is preferably a 1 ounce gold plated copper coating, having a thickness of approximately 0.0347 millimeters.

Half via holes **237**, **238** and **239** are preferably formed in the perimeter of antenna **210**, and are preferably coated with gold plated copper coatings which form a continuum with coating **232**.

When mounted on two-way transceiver element **116** (FIG. 2A), half via hole **237** is preferably grounded, half via hole **238** preferably serves as an input/output port of antenna **210**, and half via hole **239** is preferably connected to ground. The stray capacitance provided by gap **234** preferably facilitates tuning of the frequency of antenna **210**.

Reference is now made to FIG. 2D, which is a simplified pictorial illustration of antenna ground reference plane **214** which is part of two-way transceiver element **116** of FIGS. 2A & 2B. As shown in FIG. 2D, antenna ground reference plane **214** includes a flat elongate portion **240** having a length of 24.2 or 25.2 millimeters, a width of 3.3 millimeters and a thickness of 0.2 millimeters. Downward folded end portions

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**242** and **244**, having a thickness of 0.2 millimeters, extend downwardly 1.1 millimeters from corresponding ends of flat elongate portion **240**. An elongate folded side portion **246** extends outwardly 0.5 millimeters and downwardly 1.1 millimeters from a side edge of flat elongate portion **240**. Antenna ground reference plane **214** is preferably formed of stainless steel.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention includes both combinations and subcombinations of the various features described hereinabove as well as modifications thereof which would occur to persons skilled in the art upon reading the foregoing description and which are not in the prior art.

The invention claimed is:

1. A fixed magnetic contact wireless transceiver comprising:
  - a two-way transceiver element adapted to be operable for two-way wireless communication between a fixed magnetic contact wireless transceiver component and an intrusion alarm system;
  - an antenna facilitating said two-way wireless communication between said fixed magnetic contact wireless transceiver component and said intrusion alarm system; and
  - an antenna ground reference plane, opposite said antenna, wherein said antenna comprises:
    - a substrate, a top surface of said substrate being coated with a gold plated copper substrate coating, said coating having a gap formed therein; and
    - half via holes formed in a perimeter of said antenna, said half via holes being coated with gold plated copper half via hole coatings which form a continuum with said gold plated copper substrate coating of said substrate.
2. A fixed magnetic contact wireless transceiver according to claim 1 and wherein said antenna ground reference plane comprises:
  - a flat elongate portion;
  - first and second downward folded end portions extending downwardly from corresponding first and second ends of said flat elongate portion; and
  - an elongate folded side portion extending from a side edge of said flat elongate portion.
3. A fixed magnetic contact wireless transceiver according to claim 1 and wherein said antenna has a volume of less than 112 cubic millimeters.
4. A fixed magnetic contact wireless transceiver according to claim 1 and wherein said antenna has a volume of 111.84 cubic millimeters.
5. A fixed magnetic contact wireless transceiver according to claim 1 and wherein said antenna has a length of less than 24 millimeters, a width of less than 4 millimeters, and a thickness less than 2 millimeters.
6. A fixed magnetic contact wireless transceiver according to claim 1 and wherein said antenna has a length of 23.3 millimeters, a width of 3 millimeters, and a thickness of 1.6 millimeters.
7. A fixed magnetic contact wireless transceiver according to claim 2 and wherein said flat elongate portion has a volume of less than 16 cubic millimeters.
8. A fixed magnetic contact wireless transceiver according to claim 2 and wherein said flat elongate portion has a volume of 15.972 cubic millimeters.
9. A fixed magnetic contact wireless transceiver according to claim 2 and wherein:

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said flat elongate portion has a length of less than 25 millimeters, a width of less than 4 millimeters and a thickness less than 0.5 millimeters;

each of said first and second downward folded end portions has a width of less than 4 millimeters and a thickness of less than 0.5 millimeters, and extends downwardly less than 1.5 millimeters from said corresponding first and second ends of said flat elongate portion; and

said elongate folded side portion extends outwardly less than 1 millimeter and downwardly less than 1.5 millimeters from said side edge of said flat elongate portion.

**10.** A fixed magnetic contact wireless transceiver according to claim 2 and wherein:

said flat elongate portion has a length of 24.2 millimeters, a width of 3.3 millimeters and a thickness of 0.2 millimeters;

each of said first and second downward folded end portions has a width of 3.3 millimeters and a thickness of 0.2 millimeters, and extends downwardly 1.1 millimeters from said corresponding first and second ends of said flat elongate portion; and

said elongate folded side portion extends outwardly 0.5 millimeters and downwardly 1.1 millimeters from said side edge of said flat elongate portion.

**11.** A fixed magnetic contact wireless transceiver according to claim 1 and also comprising a REED switch operable for:

sensing changes in a magnetic field induced by said magnet component, said changes being potentially indicative of an intrusion; and

communicating indications of said changes to said alarm system via said two-way transceiver component.

**12.** A fixed magnetic contact wireless transceiver according to claim 1 and wherein said magnet component comprises a contact component installation marker for alignment thereof with a corresponding transceiver component installation marker comprised on said fixed magnetic contact wireless transceiver component, upon installation of said magnet component and said fixed magnetic contact wireless transceiver component.

**13.** A fixed magnetic contact wireless transceiver according to claim 1 and wherein said fixed magnetic contact wireless transceiver component also comprises a bottom housing element and two interconnecting top housing elements.

**14.** A fixed magnetic contact wireless transceiver according to claim 11 and wherein at least one of said interconnecting top housing elements comprises at least one snap-in element integrally formed therein, configured for snap-in engagement with at least one recess formed in said bottom housing element, thereby fastening said at least one of said interconnecting top housing elements to said bottom housing element and retaining said two-way transceiver element within said top and bottom housing elements.

**15.** A fixed magnetic contact wireless transceiver according to claim 14 and wherein a first one of said interconnecting top housing elements is configured for slidable fastening thereof onto said bottom housing element and for interconnecting with a second one of said interconnecting top housing elements via interconnecting latch elements integrally formed on each of said interconnecting top housing elements.

**16.** A fixed magnetic contact wireless transceiver according to claim 13 and wherein said bottom housing element comprises a battery housing element for housing a battery, and at least one snap-in element operable for retaining said battery within said battery housing.

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**17.** A fixed magnetic contact wireless transceiver according to claim 16 and wherein said battery housing element comprises at least one battery engaging element and at least one battery circuit engaging element, and said two-way transceiver element comprises at least one transceiver circuit engaging element, said battery engaging element being operable for galvanically connecting a negative contact of said battery with said at least one battery circuit engaging element, said at least one battery circuit engaging element being operable for galvanic engagement with said at least one transceiver circuit engaging element of said two-way transceiver element upon enclosing said two-way transceiver element within said housing elements.

**18.** A fixed magnetic contact wireless transceiver according to claim 1 and wherein said fixed magnetic contact wireless transceiver component also comprises a tamper switch, wherein an attempt to tamper with said fixed magnetic contact wireless transceiver component results in toggling of said tamper switch.

**19.** A fixed magnetic contact wireless transceiver according to claim 16 and wherein said two-way transceiver element comprises a battery engaging element operable for engaging a positive contact of said battery.

**20.** A fixed magnetic contact wireless transceiver according to claim 1 and wherein said antenna is configured for high frequency communication with said alarm system, said high frequency being between 2405 and 2480 MHz.

**21.** A fixed magnetic contact wireless transceiver according to claim 1 and wherein said antenna ground reference plane opposite said antenna is operative to improve the gain of said antenna and to diminish interfering effects of materials disposed in a vicinity of said fixed magnetic contact wireless transceiver component.

**22.** A fixed magnetic contact wireless transceiver according to claim 1 and wherein said materials comprise metals, and said interfering effects comprise at least one of mistuning of said antenna, degradation of performance of said antenna and degradation of a range of said antenna.

**23.** A fixed magnetic contact wireless transceiver according to claim 1 and wherein said substrate of said antenna is formed of PCB.

**24.** A fixed magnetic contact wireless transceiver according to claim 1 and wherein said antenna ground reference plane is formed of stainless steel.

**25.** A fixed magnetic contact wireless transceiver according to claim 1 and wherein said gap is located less than 2 millimeters from a first end of said antenna, and has a width which is less than 2 millimeters.

**26.** A fixed magnetic contact wireless transceiver according to claim 1 and wherein said gap is located 1 millimeter from a first end of said antenna, and has a width of 1.3 millimeters.

**27.** A fixed magnetic contact wireless transceiver according to claim 26 and wherein said half via holes comprise:

a first half via hole formed in a second end of said antenna, opposite said first end of said antenna, said first half via hole being grounded;

a second half via hole formed in said first end of said antenna, said second half via hole being grounded; and

a third half via hole formed in a side of said antenna, said third half via hole being operable as an input/output port of said antenna.

**28.** A fixed magnetic contact wireless transceiver according to claim 1 and wherein a stray capacitance provided by said gap facilitates tuning of a frequency of said antenna.

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